TRAVEL TRENDS IN U.S. CITIES: EXPLAINING THE 2000 CENSUS COMMUTING RESULTS

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ABSTRACT

As cities grow, what happens to urban form and how does that change traffic conditions? How does growing traffic affect urban structure? These questions have received considerable theoretical and empirical attention over the last 25 years. They relate to the NIMBY debate, which associates most new development with traffic problems. Yet, until recently, substantial evidence tended to show that urban growth did not lead to "traffic doomsday". These findings contradicted the standard urban model and were surprising because roads are mainly unpriced and perceived as a significant market failure. Many researchers explained the rise of suburb-to-suburb commuting (and the dispersion of employment) as a traffic "safety valve". In that case, suburbanization was more a solution than a problem. On the other hand,, recently released findings from the 2000 Census show an increase in average commuting times that is difficult to reconcile with the earlier findings. What had changed in the 1990s? This research attempts a preliminary answer to this question. The key explanation may be income growth, especially in the late 1990s.

INTRODUCTION

> "Many communities have increased their average commuting times over the 1990s -- apparently the consequence of urban sprawl." (William H Frey in *The Milken Institute Review*, 2nd Quarter, 2003, p. 5).

As cities grow, do they become more congested and even, as some say, unlivable? The question is at the center of most urban planning and development discussions. No-growth, slow-growth, smart-growth, sustainability, NIMBY, and other such sentiments can all be traced to this association. Indeed, much of conventional urban economics makes a similar point. With most economic activity at the city center, surrounding outward growth should prompt longer average commutes to the center either via longer average distances to an expanding edge and/or slower travel along more congested radial roads.

A counter-argument emphasizes the accommodations that dynamic systems, including cities with flexible land markets, can be expected to make. This view looks at the suburbanization of jobs and housing and the rise of suburb-to-suburb commuting (and reduced suburb-to-CBD commuting) as the traffic safety-valve. Various empirical studies over the past two decades have corroborated this view (see, Gordon and Wong, 1985, and Crane and Chatham, 2003, for some of the earliest and latest data assembled in support of this point).

Comparisons from the Nationwide Personal Transportation Study, for example, show that average journey-to-work travel speeds (for all privately operated vehicles) *increased* steadily from 1983 to 1995. This occurred while both average trip lengths and trip times increased, but at different rates. Setting the 1983 values at 1.00, the 1995 values for travel time were 1.14, for trip length 1.33 and for trip speed 1.17. Examining the four NPTS surveys from 1977 to 1995, Baader Hafeez (2000) concluded that,: "the survey year is not a statistically significant meaningful effect in predicting work trip travel time, travel distance and travel speed" (p. xxxiii). In other words, over a period of substantial growth and change, these distributions changed only marginally.

Yet, commuting data from the 2000 Census as well as the 2001 NHTS (National Household Travel Survey) suggest that the late 1990s were less accommodating. For the first time in many years, Census data show that there was a significant increase in average commute times. The nationwide average (only available for all modes) rose to 25.5 minutes in 2000 from 22.4 minutes in 1990, a 14.1 percent increase.[1] Data on

[1] A recent U.S. Department of Transportation (2003) contains the following footnote: "Census reports will show an increase of 3.1 minutes between 1990 and 2000, however, changes in coding procedures between 1990 and 2000 have created confounding problems in direct comparisons. In 1990, travel time of 100 minutes or more was coded as 99 minutes whereas in 2000 the top-code was 200

distributions show a decrease in the proportion of workers with short commutes (less than 20 minutes), and an increase in the proportions in most of the other trip time intervals; nevertheless, 59.7 percent of commutes fell within the range of 5 to 24 minutes (Table 1). But, given the trend, and an increase in the share of commutes longer than 25 minutes, what happened to accommodation? Also, what happened to flexible land markets?

Table 1. National distributions of travel times to work, 1990 and 2000

	1990		2000	
	Workers	Percent	Workers	Percent
Total Workers who did not work at home	111,664,249	100.0%	124,095,005	100.0%
Less than 5 minutes	4,314,682	3.9%	4,180,407	3.4%
5 to 9 minutes	13,943,239	12.5%	13,687,604	11.0%
10 to 14 minutes	17,954,128	16.1%	18,618,305	15.0%
15 to 19 minutes	19,026,053	17.0%	19,634,328	15.8%
20 to 24 minutes	16,243,343	14.5%	17,981,756	14.5%
25 to 29 minutes	6,193,587	5.5%	7,190,540	5.8%
30 to 34 minutes	14,237,947	12.8%	16,369,097	13.2%
35 to 39 minutes	2,634,749	2.4%	3,212,387	2.6%
40 to 44 minutes	3,180,413	2.8%	4,122,419	3.3%
45 to 59 minutes	7,191,455	6.4%	9,200,414	7.4%
60 to 89 minutes	4,980,662	4.5%	6,461,905	5.2%
90 or more minutes	1,763,991	1.6%	3,435,843	2.8%

Sources: Census of Population and Housing Summary File 3 (SF3), 1990 and 2000.

Some hints (and some questions) about what occurred in recent years arise from a comparison of the various NPTS/NHTS results, including the most recent one, conducted in 2001 (Tables 2.1 – 2.3). Focusing on the most widely used travel mode, privately operated vehicles (POVs), the steepest rise in commuting trip times occurred in the latest period, 1995-2001. Within metro areas, the contrast with the previous periods is slightly less, but still notable. When the same data are stratified into metro area population sizes, all but the two smallest groups experienced the travel time increases of the late 1990s.

Data in Table 2.3a show that in the years 1995-2001, the largest increases in POV travel time were in the "urbanized" areas. These are the metro areas' more densely settled parts. Table 2.3b shows that, whereas all areas experienced similar declines in POV travel speeds, the more suburban areas had the most improved physical job access, moderating some of the travel time increases. Some "safety-valve" adjustments via job dispersion were still taking place.

minutes. This coding change results in more accurate results in 2000. The value of 2.1 was obtained by recalculating Census 2000 data using the same topcoding as 1990" (p. xvii). We were not able to adjust all the small-area data used in this study. So, a caveat remains that, the 2000 data consistently but slightly overstate the actual differences with previous years.

Table 2.1. Average commute length, time, and distance from NPTS/NHTS, 1983-2001

a) Average commute length, time, and distance

	All modes[4)]				POV				Transit[3)]			
National	1983	1990	1995	2001	1983	1990	1995	2001	1983	1990	1995	2001
length (miles)	8.5	10.7	11.6	12.1	8.9	11.0	11.8	12.1	11.8	13.3	13.0	12.6
time (minutes)[1)]	18.2	19.6	20.6	23.6	17.6	19.1	20.1	22.5	39.8	41.4	42.1	56.6
speed (MPH)[2)]	28.3	33.4	34.7	32.3	30.2	34.7	35.2	32.3	18.0	18.0	19.6	19.1
MSA	1983	1990	1995	2001	1983	1990	1995	2001	1983	1990	1995	2001
length (miles)	8.5	10.6	11.7	11.9	8.8	10.9	11.9	11.8	11.8	13.2	12.9	12.4
time (minutes)	18.8	20.2	21.5	24.2	17.9	19.5	20.8	22.9	39.9	41.3	42.1	56.0
speed (MPH)	27.2	32.3	33.7	31.1	29.3	33.6	34.2	31.0	17.8	17.9	19.2	19.4
Not in MSA[5)]	1983	1990	1995	2001	1983	1990	1995	2001	1983	1990	1995	2001
length (miles)	8.6	11.0	11.2	13.0	9.2	11.4	11.6	13.3	16.4	17.7	32.0	22.6
time (minutes)	16.1	17.2	17.2	20.8	16.6	17.3	17.4	20.8	30.3	44.0	49.6	96.0
speed (MPH)	32.2	37.8	38.9	37.7	33.4	39.1	39.5	38.2	32.4	21.2	42.2	17.1

b) Annual Change (%)

	All modes				POV				Transit			
National	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
length (miles)	1.2	3.2	1.8	0.7	0.8	3.2	1.4	0.4	-0.5	1.7	-0.4	-0.6
time (minutes)	1.7	1.1	1.0	2.2	1.5	1.1	1.1	1.9	2.9	0.6	0.4	5.0
speed (MPH)	-0.3	2.4	0.8	-1.2	-0.6	2.0	0.3	-1.4	0.6	0.0	1.7	-0.4
MSA	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
length (miles)	1.1	3.1	2.1	0.2	0.7	3.2	1.8	-0.2	-0.5	1.6	-0.4	-0.7
time (minutes)	1.6	1.0	1.3	2.0	1.5	1.2	1.3	1.6	2.8	0.5	0.4	4.9
speed (MPH)	-0.4	2.5	0.9	-1.4	-0.7	2.0	0.3	-1.6	0.8	0.0	1.4	0.2
Not in MSA	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
length (miles)	1.6	3.5	0.4	2.6	1.4	3.2	0.2	2.4	2.3	1.1	12.6	-5.6
time (minutes)	1.8	0.9	0.0	3.3	1.7	0.6	0.1	3.1	7.4	5.5	2.4	11.7
speed (MPH)	0.0	2.3	0.6	-0.5	-0.2	2.2	0.2	-0.6	-2.0	-5.9	14.7	-14.0

Sources: Calculated by authors from 1983, 1990, and 1995 NPTS and 2001 NHTS.

1) Average commute time does not include time spent waiting for transportation.
2) Segmented trips are excluded in calculating average commute speed for 1990, 1995, and 2001.
3) Transit includes bus, Amtrak, commuter train, streetcar/trolley, and elevated rail/subway.
4) All modes include all other transportation modes such as airplane, taxi, school bus, bicycle, and walking in addition to POV and Transit.
5) Figures in the transit section (especially of non-metropolitan areas) should be read with caution, because the transit user sample in this spatial category is too small.

Table 2.2. Average commute length, time, and distance by MSA size, 1983-2001

	All modes				POV			
< 250k	1983	1990	1995	2001	1983	1990	1995	2001
Average commute length (miles)	6.4	8.7	10.2	9.6	6.7	9.0	10.4	9.8
Average commute time (minutes)	14.1	16.0	17.3	17.6	14.3	16.1	17.0	17.7
Average commute speed (MPH)	27.3	33.7	35.8	32.8	28.3	34.4	36.6	33.3
250k to .5m	1983	1990	1995	2001	1983	1990	1995	2001
Average commute length (miles)	8.1	9.6	10.5	9.9	8.0	9.8	10.4	10.1
Average commute time (minutes)	16.2	16.9	17.7	18.9	15.8	16.9	17.6	18.8
Average commute speed (MPH)	30.1	34.1	36.0	31.5	30.1	34.8	35.2	32.0
.5m to 1m	1983	1990	1995	2001	1983	1990	1995	2001
Average commute length (miles)	8.2	10.5	11.1	11.9	8.8	10.8	11.1	11.9
Average commute time (minutes)	17.3	18.2	19.3	21.5	17.6	18.1	19.0	21.4
Average commute speed (MPH)	28.5	34.6	35.2	33.5	29.9	35.6	35.4	33.4
1m to 3m	1983	1990	1995	2001	1983	1990	1995	2001
Average commute length (miles)	9.5	10.4	11.3	11.1	9.7	10.7	11.2	11.3
Average commute time (minutes)	20.3	19.8	19.7	22.4	19.3	19.5	19.4	21.9
Average commute speed (MPH)	28.1	32.4	34.6	30.9	30.0	33.3	34.1	31.2
3m and over	1983	1990	1995	2001	1983	1990	1995	2001
Average commute length (miles)	9.5	11.6	12.7	13.3	10.1	12.1	13.2	13.0
Average commute time (minutes)	23.5	23.3	24.5	28.5	21.4	22.0	23.5	26.2
Average commute speed (MPH)	24.5	30.9	32.4	30.3	28.4	32.8	33.4	29.8
Annual Change (%)	All modes				POV			
< 250k	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
Average commute length (miles)	0.9	4.5	3.3	-1.1	0.8	4.2	3.0	-1.0
Average commute time (minutes)	0.9	1.8	1.6	0.2	0.9	1.7	1.1	0.7
Average commute speed (MPH)	-0.2	3.1	1.3	-1.5	-0.3	2.8	1.2	-1.5
250k to .5m	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
Average commute length (miles)	0.3	2.5	1.8	-0.9	0.3	3.0	1.1	-0.4
Average commute time (minutes)	1.0	0.6	0.9	1.1	1.0	0.9	0.9	1.1
Average commute speed (MPH)	-0.7	1.8	1.1	-2.2	-0.7	2.1	0.3	-1.6
.5m to 1m	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
Average commute length (miles)	1.2	3.5	1.1	1.2	0.9	3.1	0.4	1.3
Average commute time (minutes)	1.5	0.7	1.3	1.8	1.5	0.4	0.9	2.0
Average commute speed (MPH)	-0.3	2.8	0.4	-0.8	-0.6	2.5	-0.1	-0.9
1m to 3m	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
Average commute length (miles)	0.6	1.3	1.7	-0.3	0.5	1.5	0.9	0.2
Average commute time (minutes)	1.1	-0.3	-0.2	2.2	1.0	0.2	-0.1	2.0
Average commute speed (MPH)	-0.4	2.0	1.4	-1.9	-0.6	1.5	0.5	-1.5
3m+	90-01	83-90	90-95	95-01	90-01	83-90	90-95	95-01
Average commute length (miles)	1.3	2.8	1.8	0.9	0.6	2.6	1.7	-0.2
Average commute time (minutes)	1.8	-0.1	1.0	2.6	1.6	0.4	1.3	1.8
Average commute speed (MPH)	-0.2	3.4	0.9	-1.1	-0.9	2.1	0.4	-1.9

Sources: Calculated by authors from 1983, 1990, and 1995 NPTS and 2001 NHTS.

Table 2.3a. Commute length, time, and distance by area type in MSAs, 1995-2001

	1995		2001		% Change ('95-'01)	
Commute length (miles)	All	POV	All	POV	All	POV
All	11.6	11.8	12.1	12.1	4.1%	2.2%
not in MSA	11.2	11.5	13.0	13.3	16.5%	15.3%
MSA	11.7	11.9	11.9	11.8	1.2%	-1.1%
Urban	9.6	10.0	9.4	10.1	-1.3%	1.4%
Second city	9.5	9.8	9.8	10.1	3.2%	2.4%
Suburban	11.7	11.5	12.0	11.3	3.0%	-1.6%
Town	14.6	14.7	14.2	13.7	-2.6%	-6.3%
Rural	15.0	15.1	15.7	15.5	4.5%	2.8%
Commute time (minutes)	All	POV	All	POV	All	POV
All	20.6	20.1	23.6	22.5	14.2%	11.9%
not in MSA	17.2	17.4	20.8	20.8	21.3%	19.8%
MSA	21.5	20.8	24.2	22.9	12.4%	9.9%
Urban	23.6	21.4	28.1	24.7	18.9%	15.2%
Second city	18.0	17.7	20.6	19.9	14.5%	12.6%
Suburban	21.3	20.7	24.4	23.0	14.3%	11.3%
Town	23.0	22.9	23.9	23.7	4.2%	3.5%
Rural	22.9	22.6	24.3	24.1	6.3%	6.6%
Commute speed (mph)	All	POV	All	POV	All	POV
All	34.7	35.2	32.3	32.3	-6.9%	-8.2%
not in MSA	38.9	39.5	37.7	38.2	-3.1%	-3.4%
MSA	33.7	34.2	31.1	31.0	-7.9%	-9.4%
Urban	26.7	28.0	24.3	25.6	-9.1%	-8.5%
Second city	32.4	33.3	29.5	30.0	-9.2%	-9.9%
Suburban	33.1	32.9	29.8	29.4	-10.0%	-10.7%
Town	38.3	38.3	35.8	34.6	-6.5%	-9.6%
Rural	40.1	40.2	38.8	38.3	-3.3%	-4.7%

Sources: Calculated by authors from 1995 NPTS and 2001 NHTS.
* To classify area type in metropolitan areas, a census tract level urban/rural continuum code (HTHUR) in NPTS/NHTS data is used. The classification, developed by Claritas, Inc., is mainly based on "contextual density" (see the NPTS user's guide for details).

Table 2-3b. Commute length, time, and distance by alternative area type aggregations

	1995		2001		Change ('95-'01)	
Commute length (miles)	All	POV	All	POV	All	POV
Urban	9.6	10.0	9.4	10.1	-1.3%	1.4%
Second city, Suburban, Town, Rural	12.2	12.3	12.4	12.1	1.6%	-1.4%
Urban	9.6	10.0	9.4	10.1	-1.3%	1.4%
Second city	9.5	9.8	9.8	10.1	3.2%	2.4%
Suburban, Town, Rural	13.1	13.0	13.3	12.8	1.7%	-2.1%
Urban, Second city	9.5	9.9	9.6	10.1	1.1%	2.0%
Suburban, Town, Rural	13.1	13.0	13.3	12.8	1.7%	-2.1%
Commute time (minutes)	All	POV	All	POV	All	POV
Urban	23.6	21.4	28.1	24.7	18.9%	15.2%
Second city, Suburban, Town, Rural	21.1	20.7	23.3	22.6	10.5%	8.8%
Urban	23.6	21.4	28.1	24.7	18.9%	15.2%
Second city	18.0	17.7	20.6	19.9	14.5%	12.6%
Suburban, Town, Rural	22.1	21.7	24.2	23.4	9.7%	8.0%
Urban, Second city	20.7	19.3	24.2	22.0	16.7%	13.7%
Suburban, Town, Rural	22.1	21.7	24.2	23.4	9.7%	8.0%
Commute speed (mph)	All	POV	All	POV	All	POV
Urban	26.7	28.0	24.3	25.6	-9.1%	-8.5%
Second city, Suburban, Town, Rural	35.2	35.3	32.4	32.0	-7.9%	-9.4%
Urban	26.7	28.0	24.3	25.6	-9.1%	-8.5%
Second city	32.4	33.3	29.5	30.0	-9.2%	-9.9%
Suburban, Town, Rural	35.9	35.9	33.3	32.6	-7.4%	-9.1%
Urban, Second city	29.5	30.7	27.0	27.9	-8.7%	-9.1%
Suburban, Town, Rural	35.9	35.9	33.3	32.6	-7.4%	-9.1%

Sources: Calculated by authors from 1995 NPTS and 2001 NHTS.
* To classify area type in metropolitan areas, a census tract level urban/rural continuum code (HTHUR) in NPTS/NHTS data is used. The classification, developed by Claritas, Inc., is mainly based on "contextual density" (see the NPTS user's guide for details).

To investigate possible explanations for the recent increase in average commute times, this research is, to our knowledge, the first to study aggregate commuting patterns using data on a cross-section of the Census Bureau's Urbanized Areas (UAs). Most previous research on U.S. cities used data on MSAs and CMSAs. These are aggregations of counties and most of the sub-state data are normally made available for these units. The well-known shortcoming of using county-level data for analyses that include settlement density measures is that political boundaries rarely correspond to functional boundaries. Many county boundaries overstate the extent of urbanization. It is for this reason that the Census Bureau also compiles data for Urbanized Areas whose boundaries approximate the perimeters of actual settlement, where "the lights start, when flying in at night". The trade-off is that fewer variables are available for these units.

The cross-section used in this analysis is the set of all UAs whose corresponding MSAs/CMSAs were over 500,000 population in 2000 (see Table 3 for summary descriptive statistics for the relevant variables in these UAs and the corresponding MSAs/CMSAs). The cut-off is somewhat arbitrary but these UAs include approximately 60 percent of the metro area population in both years and certainly include cities with the most severe traffic problems. The average one-way commute in these UAs in the last three Census years (for all modes) was 20.44 minutes in 1980, 20.85 minutes in 1990 and 23.62 minutes in 2000. These summaries suggest that travel time change in the 1990s and in the 1980s was different: a greater than 13 percent increase in the last decade, compared to only a 2 percent increase in the decade before. The change is not explained by more people using slower public transit because transit's share of commuting fell in each decade.

Table 3 also shows commuting time differences over the last three Census years for our sample of UAs and CMSAs/MSAs. For the UAs, through the 1990s, central city commuting times grew by slightly more than the suburban commuting times.

An ordinary least squares regression test was applied to a pooled sample of the 1990 and 2000 UAs. Using UA average commuting times as the dependent variable, the results, show that conventional variables (UA population density, size and degree of transit use) have the expected signs and explain more than 60 percent of the observed variation in commuting behavior. In addition, a dummy variable for the year of each observation is also statistically significant. This prompts the question: What happened during the decade of the 1990s?

Table 3. Summary descriptive statistics for variables

	1980		1990		2000		Change		% Change	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	80-90	90-00	80-90	90-00
UA										
COTIME	20.44	3.07	20.85	2.94	23.62	3.34	0.41	2.77	2.0%	13.3%
CCTIME	20.26	3.91	20.20	3.31	22.93	3.85	-0.06	2.72	-0.3%	13.5%
SUBTIME	20.79	2.88	21.59	2.74	24.28	3.19	0.80	2.69	3.8%	12.4%
POP	1273397	2167167	1441672	2315141	1741146	2588178	168275	299475	13.2%	20.8%
POPDENS	2595	867	2557	908	2709	1105	-37.34	151.71	-1.4%	5.9%
TRANS	6.00	5.00	4.28	4.47	3.55	4.26	-1.72	-0.73	-28.6%	-17.1%
INC	42779	4751	41506	6135	42795	6314	-1274	1289	-3.0%	3.1%
VEH			1.61	0.12	1.63	0.11		0.02		1.3%
MFWORK	55.29	4.37	59.28	4.67	57.17	4.35	3.99	-2.11	7.2%	-3.6%
CHILD	36.75	4.15	33.22	4.37	33.20	4.19	-3.53	-0.02	-9.6%	-0.1%
SUBEMPL[1)]			39.63	17.84	46.49	18.67		6.86		17.3%
FWY[2)]			0.64	0.25	0.66	0.25		0.03		4.3%
HMFLX[3)]			3.69	11.17	-6.07	15.80		-9.76		-264.6%
CMSA										
COTIME	21.00	2.79	21.53	2.58	24.42	2.97	0.54	2.89	2.5%	13.4%
CCTIME	20.13	3.64	20.03	3.13	22.72	3.58	-0.10	2.69	-0.5%	13.4%
SUBTIME	21.66	2.61	22.51	2.42	25.53	2.94	0.85	3.03	3.9%	13.4%
POP	1638177	2414935	1890645	2762115	2299365	3240893	252468	408720	15.4%	21.6%
POPDENS	486	467	497	356	494	324	10.92	-3.16	2.2%	-0.6%
TRANS	4.96	4.52	3.43	3.77	2.88	3.42	-1.54	-0.54	-31.0%	-15.8%
INC[4)]	43351	4923	41992	6241	43131	5953	-1359	1139	-3.1%	2.7%
VEH			1.68	0.12	1.70	0.11	1.68	0.01		0.8%
MFWORK	55.36	4.64	59.81	4.69	57.59	4.22	4.45	-2.22	8.0%	-3.7%
CHILD	38.30	4.33	34.53	4.33	33.88	4.04	-3.77	-0.65	-9.8%	-1.9%
SUBEMPL[1)]			46.28	15.96	51.48	16.99	46.28	5.19		11.2%
FWY[2)]			0.64	0.25	0.66	0.25	0.64	0.03		4.3%
HMFLX[3)]			3.69	11.17	-6.07	15.80		-9.76		-264.6%

Sources: Census of Population and Housing Summary File 3 (SF3), 1980, 1990 and 2000; Freeway lane miles data from the Federal Highway Administration, Highway Statistics, 1990 and 2000; Housing permits data from the Census Bureau's New Residential Construction Survey, 1990 and 2000.

Variable descriptions: COTIME: Average commute time (min.); CCTIME: Commute time in central cities; SUBTIME: Commute time in suburbs; POP: Population; POPDENS: Population density (pop/sq/mile); TRANS: % transit commuters; INC: Median household income; VEH: Vehicles per household; MFWORK: % multi-worker families; CHILD: % households with children; SUBEMPL: % suburban employment; FWY: Freeway lane miles per 1000 pop; HMFLX: Housing market flexibility (Housing permits growth rate minus population growth rate in the previous decade).

1) Suburban employment is defined as the proportion of CMSA/MSAs or UAs workers who worked outside central cities of corresponding CMSA/MSAs.

2) Since freeway lane miles data are available only for UAs, the same values are used for corresponding CMSA/MSAs.

3) Because housing permits data are available only for CMSA/MSAs, the same values are used for corresponding UAs.

4) Inflation adjustment factors, 2.48283 and 1.36668, are used for 1980 and 1990 income, respectively.

FINDINGS

To answer the research question, our approach included tests of measures of housing market flexibility, settlement change and related variables. To what extent do tough development controls such as practiced in California and many other states inhibit land market flexibility and the spatial adjustments that seemed to have worked to contain commuting times in the past? Proxies such the decentralization of jobs as well as housing permits issued per capita were developed for the UAs and were tested. In addition, some conventional explanatory variables were included.

What were the expectations with respect to the various predictors? Transit commutes are more time consuming so we expect greater transit use to increase average commuting times. A larger UA population, other things being equal, is also likely to increase congestion. Higher average incomes are associated with more travel, as are higher household vehicle ownership rates; hence both can be expected to increase commute times. (At the aggregate UA level, these two measures were surprisingly not correlated; see Appendix Table). The proportion of multi-worker households is more difficult to assess; these households engage in complex trade-offs, which may result in one spouse traveling further and the other taking a job closer to home. Along these lines, the proportion of households with children can be expected to increase commuting times because parents may accept longer commutes in order to live near better schools. Area-wide average population density may contribute to crowding and congestion or it may place residents closer to jobs; either effect is possible. The proportion of UA jobs in the suburbs may shorten commutes and is a proxy for suburb-to-suburb commuting, which we cannot measure directly with available data.. Freeway lane-miles per 1,000 UA residents, an important measure of network capacity, are expected to reduce average commute times.

A housing market flexibility proxy was constructed by computing the difference between ten-year UA housing permits growth rate (housing permits for ten years divided by housing stock in the beginning year) and ten-year population growth rate.

We kept the dummy variable for each survey year to test whether or not the set of independent variables could explain the ten-year growth in commuting times.

The findings for conventional predictors and the pooled sample of UAs (panel 3 of Table 4.1) are:

- The proportion of commuters using transit, population, average income (with change between the two years adjusted for inflation) and number of vehicles per household all had the expected *positive* effects but only the first three were statistically significant.
- Gross population densities and the proportion of suburban jobs each had the expected significantly *negative* mitigating effects. For any given density (holding

constant all of the other variables), suburban employment benefits traffic; in this sense, "sprawl" helps. Nevertheless, for any level of suburbanization, higher population densities reduce commuting times.

- Housing market flexibility, as measured by the proxy variable, and holding other effects constant, was *not* statistically significant. Before ruling out the importance of housing market flexibility altogether, it may be judicious to search for a better proxy.

- Lanes of freeway were significant, as expected, with the expected negative sign.

- The proportion of two-worker households and the proportion of households with children are both significant, but with opposite signs. This could be picking up the fact that women often have shorter commutes but also that the presence of children can generate longer commutes so that households can locate near better schools.

- The year remains highly significant.

Given an adjusted R-squared value of almost 80 percent, these results indicate that changes in the independent variables are sufficient to explain the 1990-2000 travel time increase. However, the highly significant dummy variable only deepens the mystery. The question remains: What happened in the 1990s?

The NHTS results for the last six years suggest that these were the most critical. It is known that income in the late 1990s grew much faster than in the early 1990s. Constant dollar per capita disposable income grew 3.7 percent in the period 1990-1995 but it increased by 13.9 percent over the next five years. How did year interact with income?

The fourth panel of Table 4-1 shows results for the same model already described but with all of the independent variables interacting with year. How do the results change?

- First, the shift effect of the year dummy variable disappears.

- Second, income, the proportion of two-worker households, the proportion of household with children, suburban employment cease to be statistically significant.

- Third, the three variables that remain significant (population, population density, and the proportion of transit users) show only very small changes from the prior specification in terms of the values of their estimated coefficients.

- Finally, three of the interactions are significant; they are income: rising incomes in the 1990s (most of the change occurred in the late 1990s), explained longer trips; the proportion of two-worker households reduced commuting times in the

1990s but not in the 1980s; and the availability of freeways, a stimulus to shorter duration trips, provided less of a benefit in the 1990s.

The same models estimated over the same metro areas but using CMSA/MSA data instead of UA data result in a lower R-squared, fewer significant variables and lower t-values throughout (Table 4.2). This makes sense in light of the boundary problems associated with political spatial units. Given the large number of studies that have used the CMSA/MSA approach, this result is worth noting.

Table 4.1. Estimation results of urbanized area (UA) regressions

	1990		2000		Pooled		Pooled	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	2.06604	2.29**	1.05343	0.87	1.53987	2.13**	1.65694	1.86*
POP	0.11184	9.36**	0.09034	5.76**	0.10067	10.45**	0.10219	10.59**
POPDENS	-0.09543	-2.87**	-0.06852	-1.76*	-0.08158	-3.32**	-0.08315	-3.29**
TRANS	0.05384	3.18**	0.04471	2.07**	0.05184	3.89**	0.05050	3.74**
INC	0.03383	0.33	0.35707	2.55**	0.18069	2.19**	0.07653	0.74
VEH	0.16282	1.14	0.17830	0.88	0.17616	1.47	0.11562	0.81
MFWORK	-0.17155	-1.07	-0.79083	-3.58**	-0.43329	-3.28**	-0.17282	-1.02
CHILD	0.10540	1.53	0.21512	2.36**	0.14646	2.62**	0.11323	1.54
SUBEMPL	-0.00459	-0.30	-0.02832	-1.38	-0.02097	-1.73*	-0.00589	-0.35
FWY	-0.06609	-3.41**	-0.01415	-0.50	-0.04217	-2.66**	-0.06490	-3.12**
HMFLX	-0.00049	-0.77	-0.00021	-0.30	-0.00021	-0.49	-0.00034	-0.72
YINC 1)							0.21162	1.66*
YVEH 1)							0.13967	0.77
YMFWORK 1)							-0.59679	-2.38**
YCHILD 1)							0.07931	0.78
YSUBEMPL 1)							-0.02592	-1.06
YFWY 1)							0.05244	1.72*
YEAR					0.09992	7.52**	0.04512	0.05
R-squared	77		79		156		156	
Adj. R-sq.	0.817		0.737		0.800		0.811	
Obs.	0.789		0.698		0.785		0.788	

* significant at 0.1 level. ** significant at 0.05 level.
*** Dependent variable is log of average commute time. All independent variables except HMFLX and YEAR are in natural log form.
1) All variables beginning with Y are interacting variables.

Table 4.2. Estimation results of metropolitan area (MSA/CMSA) regressions

	1990		2000		Pooled		Pooled	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	1.64848	1.62	1.00437	0.81	1.42127	1.82*	1.35584	1.47
POP	0.10164	6.59**	0.07557	4.40**	0.09057	7.87**	0.09007	7.87**
POPDENS	-0.02706	-1.66	0.00706	0.44	-0.00998	-0.87	-0.00854	-0.75
TRANS	0.02486	1.34	0.01355	0.71	0.02108	1.61	0.01851	1.41
INC	0.03449	0.30	0.37903	2.63**	0.16580	1.89*	0.06750	0.64
VEH	-0.00545	-0.03	0.08505	0.40	0.05689	0.42	-0.02057	-0.13
MFWORK	-0.08952	-0.52	-0.89367	-4.23**	-0.41254	-3.12**	-0.10291	-0.59
CHILD	0.04294	0.54	0.19053	2.10**	0.10390	1.76*	0.06115	0.77
SUBEMPL	-0.00646	-0.32	-0.01545	-0.67	-0.01448	-0.95	-0.00750	-0.36
FWY	-0.01971	-0.93	0.03213	1.24	0.00206	0.13	-0.01923	-0.88
HMFLX	-0.00005	-0.06	-0.00009	-0.14	0.00003	0.07	-0.00001	-0.01
YINC 1)							0.24000	1.85*
YVEH 1)							0.15399	0.80
YMFWORK 1)							-0.73193	-2.79**
YCHILD 1)							0.09455	0.85
YSUBEMPL 1)							-0.00753	-0.25
YFWY 1)							0.04987	1.54
YEAR					0.09413	6.94**	0.15283	0.15
R-squared	77		79		156		156	
Adj. R-sq.	0.695		0.679		0.734		0.749	
Obs.	0.648		0.631		0.714		0.718	

* significant at 0.1 level. ** significant at 0.05 level.
*** Dependent variable is log of average commute time. All independent variables except HMFLX and YEAR are in natural log form.
1) All variables beginning with Y are interacting variables.

Looking at the estimated elasticities in Table 5, the results suggest that the growth of the UA population accounted for part of the increase in commuting times with a few minor offsets provided by higher densities, more transit use and more freeway availability. Together, all these effects predict a commute time increase of only1.7 percent out of a 13.3 percent increase.[2] Given the high R-squared and the three significant interaction effects, the changed responses (slopes) in the 1990s were the most important result.

[2] The caveat mentioned in the first footnote still holds . However, the time changes result in minor overestimates.

Table 5. Estimated elasticities and their relative effects for mean sample observations

Independent variables	t-value	Coefficient	UA average independent variables % Change	Estimated % Change of dependent variable
Population	**10.59**	**0.10219**	**20.8**	**2.12**
Population density (pop/miles^2)	**-3.29**	**-0.08315**	**5.9**	**-0.49**
Percentage commuting via transit	**3.74**	**0.05050**	**-17.1**	**-0.87**
Household income	0.74	0.07653	3.1	0.24
Vehicles per household	0.81	0.11562	1.3	0.15
Percentage multi-worker families	-1.02	-0.17282	-3.6	0.61
Percentage HHs with children	1.54	0.11323	-0.1	-0.01
Percentage suburban employment	-0.35	-0.00589	17.3	-0.10
Freeway lane miles per 1000 pop	**-3.12**	**-0.06490**	**4.3**	**-0.28**
Housing market flexibility	-0.72	-0.00034	-975.9	0.33
Observed commute time change				**13.31**
Predicted change by I.V. value change				**1.71**
Residual (Change in behavior)				**11.60**

CONCLUSIONS

The extent of market responses as a relief of traffic congestion remains a key question. Land and housing markets were more effective in the 1980s than in the 1990s. Answers to this question have important implications for planners, developers and policymakers as they grapple with "smart growth" and other prescribed solutions.

Our empirical results are decidedly mixed with respect to this question. Findings from the Census and the NPTS/NHTS are consistent. The Census results suggest that the 1990s differed from the 1980s; income was more important in the second decade. The NPTS/NHTS data suggest that the late 1990s differed from previous periods. This latter period experienced the strongest real income growth. The fact that "income matters" is not a surprise.. A plausible explanation would be a link between income and the number of trips (not solely worktrips) that people take. Higher-income households may also more likely to accept longer commutes in order to consume the larger houses and more land available at more distant, especially exurban, locations.. The spurt of late-1990s affluence was too much for the urban growth accommodation system in place at the time. Growth and unpriced access could be handled in previous years but not with the "income shock" of the late 1990s,..

Looking at trip *rates,* (Table 6 and Figure 1), all of the rates fell. It appears that population growth and income growth along with slow capacity expansion pushed up travel costs. In response to higher costs, there was some reduction of trip-making.

Preliminary findings suggest that the proportion of workers who worked at home increased slightly, from 5.8 percent in 1995 to 6 percent in 2001. These data require further analysis before any significance can be ascribed to the small increase.

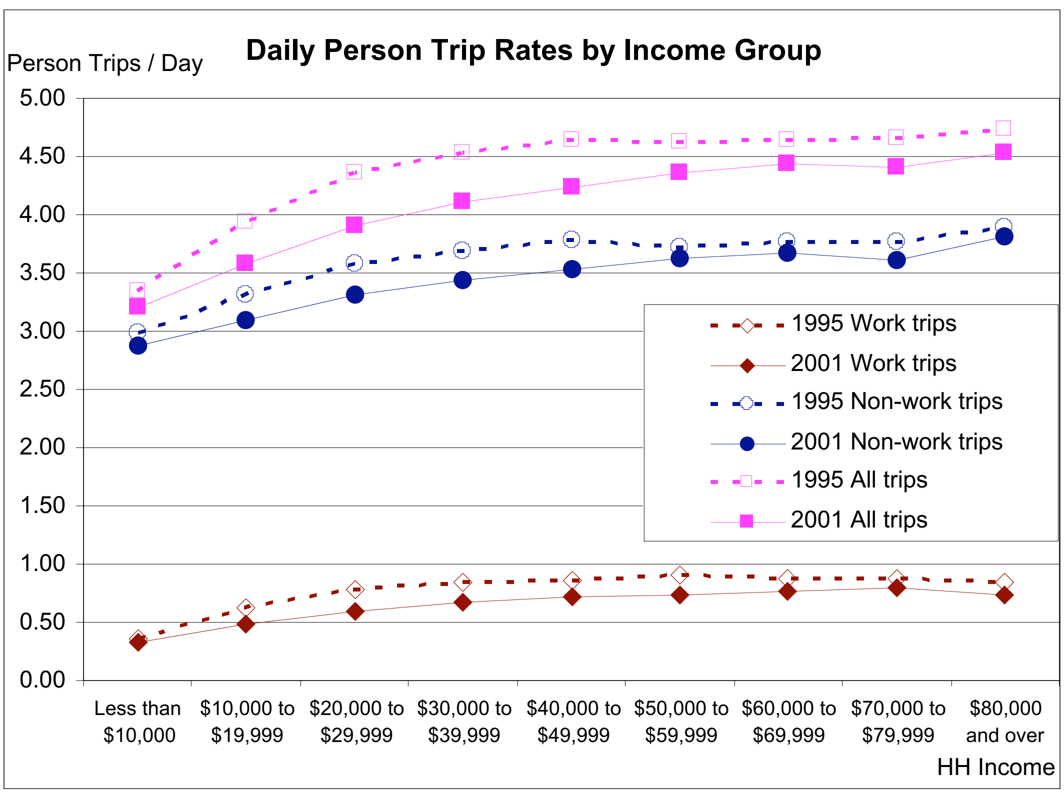
In terms of the role of planners and policymakers, the results suggest that the answer is not more transit use, but more roads. The stock objection of "latent demand" – that we cannot build ourselves out of congestion is problematic, to say the least. Time-of-day pricing can improve the situation even more. Planners have no effective means of limiting metro-area population or income growth. In most situations, controls have negative outcomes. Hence, land and housing market flexibility, which worked well in the past, is more of a priority than ever.

Table 6. Work and non-work daily trip frequencies by income group, 1995 and 2001

	1995			2001		
	Work trip	Nonwork trip	All trip	Work trip	Nonwork trip	All trip
Less than $10,000	0.36	2.99	3.35	0.33	2.87	3.20
$10,000 to $19,999	0.63	3.31	3.94	0.48	3.09	3.57
$20,000 to $29,999	0.79	3.57	4.36	0.60	3.31	3.91
$30,000 to $39,999	0.84	3.69	4.54	0.68	3.44	4.12
$40,000 to $49,999	0.86	3.78	4.64	0.71	3.53	4.24
$50,000 to $59,999	0.91	3.72	4.63	0.74	3.62	4.36
$60,000 to $69,999	0.87	3.77	4.64	0.76	3.67	4.43
$70,000 to $79,999	0.88	3.77	4.65	0.80	3.61	4.41
$80,000 and over	0.84	3.89	4.73	0.73	3.81	4.54
All	0.76	3.54	4.30	0.65	3.45	4.10

1) In computing 2001 daily trips per person, only people over 5 years old are accounted, because only people over 5 years old were interviewed in the 1995 NPTS survey.

Figure 1. Work and nonwork daily trip frequencies by income group, 1995 and 2001



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APPENDIX

Table A1. Correlation statistics for variables in UAs, 1990 and 2000

1990	Cotime	Pop	Popdens	Trans	Inc	Veh	Mfwork	Child	Subempl	Fwy	Hmflx
COTIME	1.00										
POP	0.87	1.00									
POPDENS	0.50	0.60	1.00								
TRANS	0.69	0.71	0.58	1.00							
INC	0.49	0.54	0.32	0.60	1.00						
VEH	-0.21	-0.26	-0.31	-0.43	0.12	1.00					
MFWORK	0.15	0.15	-0.12	0.29	0.65	0.42	1.00				
CHILD	-0.02	-0.11	-0.02	-0.19	-0.27	0.33	0.08	1.00			
SUBEMPL	0.23	0.33	0.35	0.36	0.37	-0.25	-0.05	-0.33	1.00		
FWY	-0.24	-0.14	-0.41	-0.07	0.08	0.25	0.35	0.09	-0.04	1.00	
HMFLX	-0.04	0.01	-0.09	-0.08	-0.09	0.09	0.03	0.01	0.05	0.00	1.00

2000	Cotime	Pop	Popdens	Trans	Inc	Veh	Mfwork	Child	Subempl	Fwy	Hmflx
COTIME	1.00										
POP	0.80	1.00									
POPDENS	0.51	0.61	1.00								
TRANS	0.66	0.75	0.63	1.00							
INC	0.49	0.54	0.24	0.58	1.00						
VEH	-0.22	-0.29	-0.26	-0.43	0.17	1.00					
MFWORK	0.10	0.21	0.00	0.28	0.73	0.45	1.00				
CHILD	0.09	0.03	0.21	-0.05	-0.13	0.34	0.18	1.00			
SUBEMPL	0.18	0.29	0.03	0.30	0.23	-0.24	-0.03	-0.33	1.00		
FWY	-0.22	-0.19	-0.35	-0.05	0.12	0.24	0.41	0.06	-0.13	1.00	
HMFLX	-0.20	-0.12	-0.12	-0.04	-0.25	-0.02	0.05	0.12	-0.02	0.48	1.00

1) All variables except HMFLX and YEAR are used in natural log form.